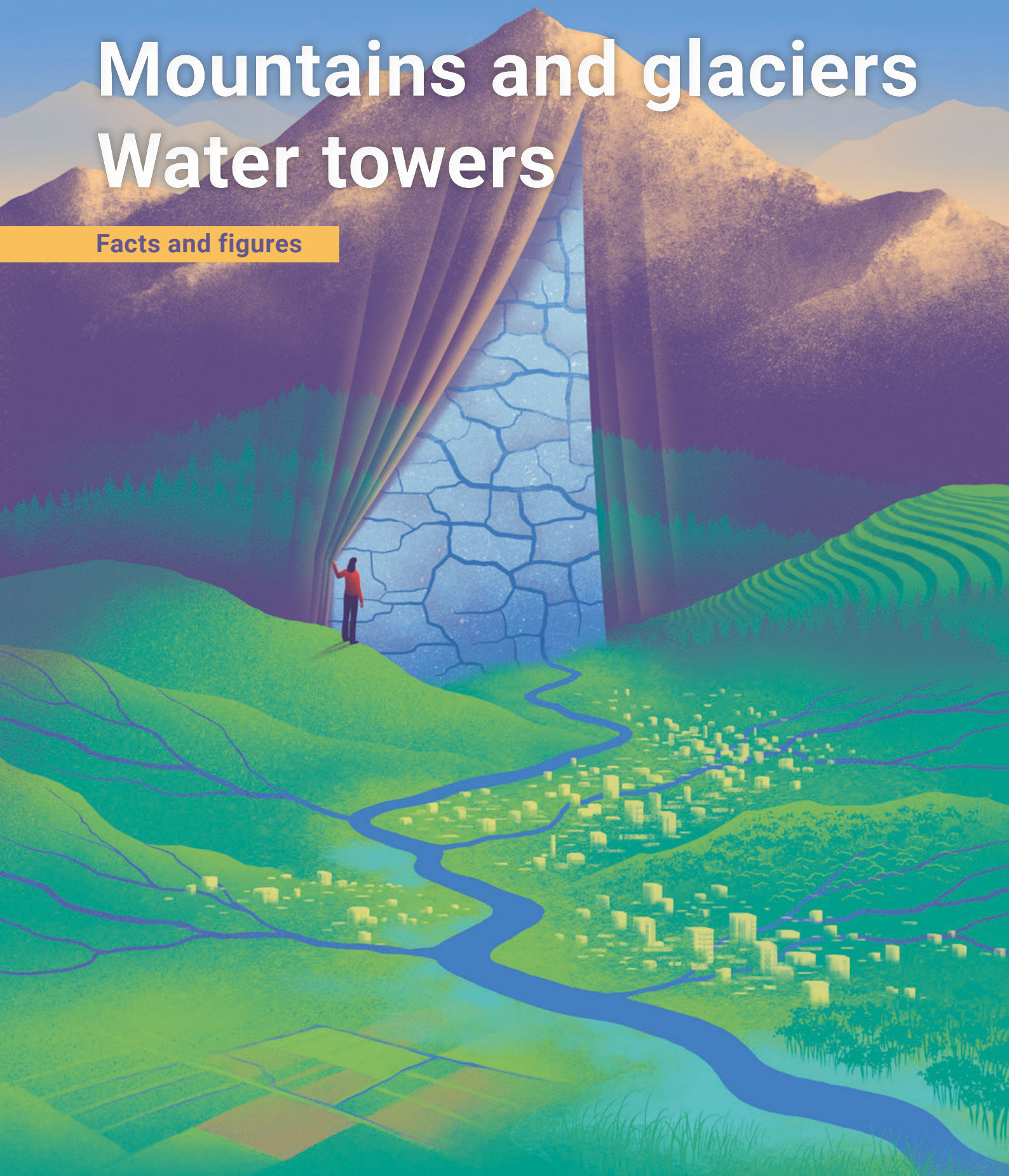
UN WATER

unesco

The United Nations World Water Development Report 2025

Mountains and glaciers Water towers

Facts and figures



Trends in water demand and availability

According to the most recent global estimates from 2021, the agriculture sector dominates total water withdrawals (72%), followed by industry (15%) and domestic (or municipal) use (13%). Over the period 2000–2021, total freshwater withdrawals grew by 14% globally (from 3,500 km^3 in 2000 to just under 4,000 km^3 in 2021), giving an average increase of 0.7% per year (FAO, n.d.).

Higher-income countries use more water for industry, whereas lower-income countries use 90% (or more) of their water for agricultural irrigation (Kashiwase and Fujs, 2023).

Twenty-five countries – home to one-quarter of the world's population – face 'extremely high' water stress every year (Kuzma et al., 2023).

Approximately 4 billion people, or half the entire world's population, experience severe water scarcity for at least part of the year (IPCC, 2023a).

Progress towards Sustainable Development Goal 6

Target 6.1: Safe drinking water

An estimated 2.2 billion people (27% of the global population) were without access to safely managed drinking water in 2022. Four out of five people lacking at least basic drinking water services lived in rural areas (United Nations, n.d.a).

Target 6.2: Access to sanitation and hygiene

As of 2022, 3.5 billion people worldwide lacked access to safely managed sanitation (UNICEF/WHO, 2023). The situation was particularly dire in Sub-Saharan Africa, where a mere 24% of the population used safely managed sanitation services. Lack of access also persists in other regions, such as Latin America and the Caribbean, and Central and Southern Asia, where only roughly 50% of the population had access to these services (United Nations, n.d.b).

Target 6.3: Water quality

In 2023, data on 91,000 water bodies from 120 countries revealed that 56% had good water quality (United Nations, 2024).

Target 6.4: Water-use efficiency

Globally, around 58% of countries still exhibit low water-use efficiency (less than US$20/$m^3$) (United Nations, 2024).

Target 6.5: Transboundary water cooperation

Out of 153 countries sharing transboundary rivers, lakes and aquifers, only 43 have 90% or more of their transboundary waters covered by operational arrangements. Only 26 countries have all their transboundary waters covered by operational arrangements (UNECE/UNESCO/UN-Water, 2024).

Target 6.6: Water-related ecosystems

Data trends show water-related ecosystems are continuing to face significant levels of degradation. This is primarily driven by pollution, dams, land conversion, overabstraction and climate change (UNEP, 2024a).

Target 6.a: International cooperation on water and sanitation

Official development assistance disbursements to the water sector steadily decreased from 2018 to 2020, then rose by 11% to US$9.1 billion in 2021 (United Nations, n.d.c).

Target 6.b: Participatory water and sanitation management

Over 90% of countries reported having procedures for participation defined in law or policy for rural drinking water and water resources management over the 2021–2022 reporting cycle. However, less than one-third of countries reported high or very high participation of communities in planning and management processes (WHO, 2022).

Mountain areas of the world

Mountain regions cover around 33 million km^2 – or 24% of the global land surface, excluding Antarctica (Romeo et al., 2020). In 2015, some 1.1 billion people (around 15% of the world's population) resided in mountain regions (Adler et al., 2022) – nearly doubling from just over 575 million in 1975 (Thornton et al., 2022). For comparison, around 900 million people lived in deltas and low-lying coastal regions, including islands, in 2020 (Glavovic et al., 2022).

In 2015, 34% of the global mountain population lived in cities with more than 50,000 inhabitants, 31% in towns and semi-dense areas, and 35% in rural areas (Ehrlich et al., 2021).

In 2017, most of the global mountain population (around 91%) lived in developing countries. Around 90% of the total mountain population lived at elevations between 1,500 metres above sea level (masl) and 2,500 masl, with only around 75 million people living higher than 2,500 masl (Tremblay and Ainslie, 2021).

Mountain water usage and dependency

Mountains supply more surface runoff per unit area than lowlands, providing 55–60% of global annual freshwater flows. However, specific values range from 40% to over 90% in different parts of the world (Viviroli et al., 2020).

Key rivers that have been heavily influenced by water sources from mountains (>90% of the mean annual flow) include the Amu Darya, Colorado, Nile, Orange and Rio Negro. Rivers that have depended on mountain waters for more than 70% of their flow include the Euphrates, Indus, São Francisco, Senegal and Tigris (Viviroli et al., 2020).

Globally, up to two-thirds of irrigated agriculture may depend on mountain waters, while the number of people in lowlands that strongly depend on water from mountains increased worldwide from around 0.6 billion in the 1960s to some 1.8 billion in the 2000s. An additional 1 billion people in the lowlands benefit from supportive mountain runoff contributions (Viviroli et al., 2020).

Changes in the cryosphere and impacts on water

It is often stated that about 2 billion people depend on mountains – and therefore on contributions from the melting cryosphere – for their freshwater supply. This is a number derived from the estimate that 2 billion people live in drainage basins that originate in mountains (Immerzeel et al., 2020; Viviroli et al., 2020).

Trends in the mountain cryosphere

Trends across mountain basins include a greater fraction of precipitation falling as rain rather than snow, reduced snow redistribution and snow-covered area, and earlier snow-melt.

The retreat and loss of glaciers have been ongoing since the 20th century in most parts of the world (DeBeer et al., 2020; IPCC, 2023b), and have accelerated in recent decades (Zemp et al., 2019). Most mountain glaciers around the world are thinning rapidly (Hugonnet et al., 2021) and are out of balance with the current climate. This means they will continue to shrink regardless of reductions in greenhouse gas emissions (Cook et al., 2023). Further atmospheric warming will exacerbate the imbalance globally; with global warming of between 1.5°C and 4°C, mountain glaciers worldwide are projected to lose 26% to 41% of their total mass by 2100, relative to 2015. A great number of individual glaciers will disappear entirely, leaving many currently glaciated mountain headwaters unglaciated (Rounce et al., 2023).

Buytaert et al. (2017) found that in the tropical Andes, the monthly maximum area of irrigated land sourcing at least 25% of water from glacier melt doubled during drought years.

The total area and number of glacial lakes have increased significantly since the 1990s as glaciers have receded. More of these lakes will develop over the next decades, creating new hotspots of potentially dangerous glacial lake outburst floods (GLOF) hazards and risks (Adler et al., 2022).

Although not constrained to cryospheric geohazards, Stäubli et al. (2018) calculated that the absolute economic losses in mountain regions across 713 events between 1985 and 2014 exceeded US$56 billion, affected over 258 million people and resulted in over 39,000 deaths.

Food and agriculture

Agriculture and pastoralism are essential sources of livelihoods for people in mountain areas (FAO, 2019), where an estimated 1.1 billion live. In developing countries, an estimated 648 million people in mountain areas live in rural areas, where most of the population is engaged in agricultural and pastoral livelihoods.

Food and nutrition security in mountain regions is lower than in the lowlands, with 35–40% of the mountain population being food insecure and half of them suffering from chronic hunger (Romeo et al., 2020).

It has been estimated that 45% of the world's mountain areas are not, or are only marginally, suitable for growing crops, pastoralism or carrying out forestry activities (Romeo et al., 2020).

Forests cover an estimated 40% of mountain areas, performing a protective function against natural hazards by stabilizing steep slopes, regulating flows to groundwater, reducing surface runoff and soil erosion, and mitigating the potential for landslides and floods (Romeo et al., 2021; FAO, 2022).

From 2003 to 2013 in developing countries, the agricultural sector has been affected by 25% of climate-related hazards, which were responsible for 80% of the damage and loss to livestock and crop production in mountain areas (Romeo et al., 2020).

Human settlements and disaster risk reduction

Mountain regions are important water towers, sustaining human settlements home to 14% of the world's population (Ehrlich et al., 2021).

Between 1975 and 2015, approximately 35% of mountain subregions experienced at least a twofold increase in population (Thornton et al., 2022). The proportion of urban residents within these mountain areas ranged from 6% to 39% over the same period (Ehrlich et al., 2021; Thornton et al., 2022).

About 1.1 billion people live in mountain regions. Although the urbanization rate varies considerably across mountain ranges, approximately 34% of the population in mountains lives in cities, 31% in towns and semi-dense areas, and 35% in rural areas. The urbanization rate in mountains (66%) is lower than in lowlands (78%) (Ehrlich et al., 2021).

From 850 to 2022, 3,151 GLOF events were recorded across the world's major glaciated regions (Lützow et al., 2023).

Water, sanitation and hygiene, and disaster management are priority sectors in mountainous developing countries (MDCs). The estimated adaptation finance needs specifically for MDCs amounts to US$187 billion per year (in 2021 prices), equivalent to 1.3% of their gross domestic product, for this decade. Adaptation finance needs in the health and sanitation, water supply and disaster risk reduction (DRR) sectors together account for almost 20% of the MDC total adaptation finance needs. However, the available international public adaptation finance flow in these countries in 2022 was only US$13.8 billion, thus indicating a large adaptation finance gap, including in the water supply, DRR, and health and sanitation sectors in mountain regions. Even though there are huge adaptation finance gaps, these sectors collectively account for nearly 30% of the current adaptation finance flow in MDCs (UNEP, 2024b).

Industry and energy

The area spanning the southwest of the Plurinational State of Bolivia and northern Argentina and Chile accounts for 56% of the world's total identified lithium resources. Around 2,000 m^3 of water is required to produce 1 tonne of lithium (UNECLAC, 2023).

Owing to the global expansion of water-dependent industries, it is likely that industrial use of water is also growing in mountains. For instance, at the global level, material resource extraction could increase by almost 60% above the 2020 level by 2060 (UNEP, 2024c).

Cryptomining is a key process in the issuance of cryptocurrency that uses specialized computing resources requiring vast amounts of cheap energy. Coal is the main source of energy used, with a 45% share, and hydropower the main source of renewable energy, with 16% (Chamanara and Madani, 2023). Both are often produced in mountain areas, with significant impacts on the quantity and quality of water resources.

Pumped storage hydropower (PSH) utilizes excess off-peak electricity to pump water back into a reservoir, thus storing water and potential energy. PSH accounts for 95% of the world's electricity storage capacity, mostly in mountain areas (IRENA, 2023).

Environment

Mountain systems are generally characterized by lower temperatures and higher precipitation than other landscapes (FAO, 2022), and host 25 of the world's 34 biodiversity hotspots (FAO/UNEP, 2023).

In mountain ecosystems, forests cover approximately 40% of the global mountain area. At higher elevations, forests give way to grasslands and alpine tundra, including permafrost and glaciers (FAO/UNEP, 2023).

As of 2020, 57% of the global mountain area was under intense pressure, with ecosystem degradation concentrated at lower mountain elevations, where most human activities occur (Elsen et al., 2020).

Regional perspectives

Sub-Saharan Africa

Africa accounts for 11% of the global mountain area, covering an area of around 1.5 million km^2 (Alweny et al., 2014). Of continental Africa's land area, 20% is classified as mountains with an elevation over 1,000 masl, with 5% rising over 1,500 masl (FAO, 2015). East Africa is the most mountainous region in Africa.

As of 2017, Africa's mountains were home to an estimated 252 million people – 18% of the continent's population – representing 23% of the global mountain population (Romeo et al., 2020).

In 2017, an estimated 132 million rural mountain people were vulnerable to food insecurity in Africa, equating to two of out of every three rural people (Romeo et al., 2020).

Of the rural mountain people vulnerable to food insecurity in Africa in 2017, 86 million lived in areas characterized by land degradation detrimentally affecting agriculture-based livelihoods (Romeo et al., 2020).

Glaciers are projected to disappear before 2030 on Mount Kenya and the Rwenzori Mountains, and by 2040 on Mount Kilimanjaro (Trisos et al., 2022).

Europe and Central Asia

By 2100, the effects of climate change on the cryosphere and hydrosphere in the Alps are expected to lead to a decrease in annual river discharge where the runoff from the ice-covered part decreases by 45% and the total runoff decreases by 35% by 2100 relative to 2006 (Laurent et al., 2020).

The Carpathian Mountains are home to approximately 30% of European flora and to Europe's largest populations of brown bear, wolf, lynx, European bison and rare bird species (UNEP, 2023).

Latin America and the Caribbean

Water towers in Latin America and the Caribbean occupy about one-third of the regional territory (FAO, 2000), and produce more water flow per land area than any other continent (Bretas et al., 2020).

The Andes Mountain range (the longest mountain chain in the world, extending over 7,000 km) is the largest supplier to the region's water flows (FAO, 2000), contributing to 50% of the flow of the Amazon River (Bretas et al., 2020).

As of 2017, approximately 25% (167 million people) of the population in Latin America and the Caribbean lived in mountains, of which 112 million resided in urban areas. Some 17 million people lived in mountain areas often vulnerable to intense climate variability and soil degradation (Romeo et al., 2020).

According to the Intergovernmental Panel on Climate Change, global warming has caused glacier loss in the Andes, ranging from 30% to 50% of the area since the 1980s, marking one of the most significant declines globally (IPCC, 2022).

In Latin America, 85% of hydroelectric power came from mountain sources in 2013 (Mountain Partnership, 2013).

Asia and the Pacific

The Tibetan Plateau and surrounding Pamir–Hindu Kush Himalaya (HKH) mountain ranges and the Hengduan, Tien Shan and Qilian mountains encompass 5 million km^2 of high mountains, with 100,000 km^2 of glaciers. This so-called Third Pole – also sometimes referred to as the water tower of Asia – stores more ice and snow than any other region outside the Antarctic and Arctic (UNEP, 2022). The Third Pole is the origin of more than ten river systems that are vital for sustaining nearly 2 billion individuals in the river basins of Central, Northeast, South and Southeast Asia (ICIMOD, 2023).

Glaciers in the HKH region are disappearing at an alarming rate: 65% faster in 2011–2020 than in the previous decade (ICIMOD, 2023). They are also melting faster than the global average (Mani, 2021), with the most significant losses concentrated in the eastern HKH region (ESCAP/UNEP/ILO/UNFCCC RCC Asia-Pacific/UNIDO, 2023).

It has been projected that under global warming scenarios of 1.5–2°C, glacier volume in the HKH region may reduce by 30–50% by 2100. If global warming exceeds 2°C, these glaciers may shrink down to 20–45% of their 2020 volume (ICIMOD, 2023).

Retreat of glaciers has been observed in the Southern Alps in New Zealand, and by 2100, the country is projected to lose 88% of its ice volume as compared to 2011 (Frazier and Brewington, 2020).

Arab region

Approximately one-third of the the people who live in the Arab region resides 600 masl (ESCWA, 2022).

It has been estimated that snow contributes 50–60% of the water volume in Lebanon's rivers and springs, which feeds into groundwater aquifers (Shaban, 2020).

References

Adler, C., Wester, P., Bhatt, I., Huggel, C., Insarov, G., Morecroft, M., Muccione, V. and Prakash, A. 2022. Mountains. H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem and B. Rama (eds), *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK/New York, Cambridge University Press, pp. 2273–2318. doi.org/10.1017/9781009325844.022.

Alweny, S., Nsengiyumva, P. and Gatarabirwa, W. 2014. *Africa Sustainable Mountain Development Technical Report No. 1*. Kampala/Cambridge, UK, Albertine Rift Conservation Society (ARCOS). doi.org/10.13140/RG.2.2.11656.16640.

Bretas, F., Casanova, G., Crisman, T., Embid, A., Martin, L., Miralles, F. and Muñoz, R. 2020. *Agua para el Futuro: Estrategia de Seguridad Hídrica para América Latina y el Caribe* [Water for the Future: Water Security Strategy for Latin America and the Caribbean]. Inter-American Development Bank (IDB). doi.org/10.18235/0002816. (In Spanish.)

Buytaert, W., Moulds, S., Acosta, L., De Bièvre, B., Olmos, C., Villacis, M., Tovar, C. and Verbist, K. M. 2017. Glacial melt content of water use in the tropical Andes. *Environmental Research Letters*, Vol. 12, No. 11, Article 114014. doi.org/10.1088/1748-9326/aa926c.

Chamanara, S. and Madani, K. 2023. *The Hidden Environmental Cost of Cryptocurrency: How Bitcoin Mining Impacts Climate, Water and Land*. Hamilton, Canada, United Nations University Institute for Water, Environment and Health (UNU-INWEH). doi.org/10.53328/INR23ASC02.

Cook, S. J., Jouvet, G., Millan, R., Rabatel, A., Zekollari, H. and Dussaillant, I. 2023. Committed ice loss in the European Alps until 2050 using a deep-learning-aided 3D ice-flow model with data assimilation. *Geophysical Research Letters*, Vol. 50, No. 23, Article e2023GL105029. doi.org/10.1029/2023GL105029.

DeBeer, C. M., Sharp, M. and Schuster-Wallace, C. 2020. Glaciers and ice sheets. M. I. Goldstein and D. A. DellaSala (eds), *Encyclopedia of the World's Biomes*. Amsterdam/Oxford, UK/Cambridge, USA, Elsevier, pp. 182–194. doi.org/10.1016/B978-0-12-409548-9.12441-8.

Ehrlich, D., Melchiorri, M. and Capitani, C. 2021. Population trends and urbanisation in mountain ranges of the world. *Land*, Vol. 10, No. 3, Article 255. doi.org/10.3390/land10030255.

Elsen, P. R., Monahan, W. B. and Merenlender, A. M. 2020. Topography and human pressure in mountain ranges alter expected species responses to climate change. *Nature Communications*, Vol. 11, Article 1974. doi.org/10.1038/s41467-020-15881-x.

ESCAP/UNEP/ILO/UNFCCC RCC Asia-Pacific/UNIDO (Economic and Social Commission for Asia and the Pacific/United Nations Environment Programme/International Labour Organization/The Regional Collaboration Center for Asia-Pacific of the Secretariat of the United Nations Framework Convention on Climate Change/United Nations Industrial Development Organization). 2023. *2023 Review of Climate Ambition in Asia and the Pacific: Just Transition Towards Regional Net-Zero Climate Resilient Development*. United Nations. www.unescap.org/kp/2023/2023-review-climate-ambition-asia-and-pacific-just-transition-towards-regional-net-zero.

ESCWA (Economic and Social Commission for Western Asia). 2022. *Groundwater in the Arab Region – ESCWA Water Development Report 9*. Beirut, United Nations. www.unescwa.org/publications/water-development-report-9.

FAO (Food and Agriculture Organization of the United Nations). 2000. Twenty-sixth FAO Regional Conference for Latin America and the Caribbean, Mérida, Mexico, 10–14 April 2000. Sustainable Development in Mountain Areas. www.fao.org/4/x4442e/x4442e.htm.

——. 2015. *Mapping the Vulnerability of Mountain Peoples to Food Insecurity*. Rome, FAO. https://openknowledge.fao.org/handle/20.500.14283/i5175e.

—. 2019. *Mountain Agriculture: Opportunities for Harnessing Zero Hunger in Asia*. Bangkok, FAO. www.fao.org/3/ca5561en/ca5561en.pdf.

—. 2022. *The State of the World's Land and Water Resources for Food and Agriculture 2021: Systems at Breaking Point*. Main Report. Rome, FAO. doi.org/10.4060/cb9910en.

—. n.d. AQUASTAT Dissemination System. FAO website. https://data.apps.fao.org/aquastat/?lang=en. (Accessed on 2 December 2024.)

FAO/UNEP (Food and Agriculture Organization of the United Nations/United Nations Environment Programme). 2023. *Restoring Mountain Ecosystems: Challenges, Case Studies and Recommendations for Implementing the UN Decade Principles for Mountain Ecosystem Restoration*. Rome/Nairobi, FAO/UNEP. doi.org/10.4060/cc9044en.

Frazier, A. G. and Brewington, L. 2020. Current changes in alpine ecosystems of Pacific Islands. *Encyclopedia of the World's Biomes*, pp. 607–619. Elsevier. doi.org/10.1016/B978-0-12-409548-9.11881-0.

Glavovic, B. C., Dawson, R., Chow, W., Garschagen, M., Haasnoot, M., Singh, C. and Thomas, A. 2022. Cities and settlements by the sea. H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem and B. Rama (eds), *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK/New York, Cambridge University Press, pp. 2163–2194. doi.org/10.1017/9781009325844.019.

Hugonnet, R., McNabb, R., Berthier, E., Menounos, B., Nuth, C., Girod, L., Farinotti., D., Huss, M., Dussaillant, I., Brun, F. and Kääb, A. 2021. Accelerated global glacier mass loss in the early twenty-first century. *Nature*, Vol. 592, pp. 726–731. doi.org/10.1038/s41586-021-03436-z.

ICIMOD (International Centre for Integrated Mountain Development). 2023. *Water, Ice, Society, and Ecosystems in the Hindu Kush Himalaya: An Outlook* [P. Wester, S. Chaudhary, N. Chettri, M. Jackson, A. Maharjan, S. Nepal and J. F. Steiner (eds)]. Kathmandu, ICIMOD. doi.org/10.53055/ICIMOD.1028.

Immerzeel, W. W., Lutz, A. F., Andrade, M., Bahl, A., Biemans, H., Bolch, T., Hyde, Brumby, S., Davies, B. J., Elmore, A. C., Emmer, A., Feng, M., Fernández, A., Haritashya, U., Kargel, J. S., Koppes, M., Kraaijenbrink, P. D. A., Kulkarni, A. V., Mayewski, P. A., Nepal, S., Pacheco, P., Painter, T. H., Pellicciotti, F., Rajaram, H., Rupper, S., Sinisalo, A., Shrestha, A. B., Viviroli, D., Wada, Y., Xiao, C., Yao, T. and Baillie, J. E. M. 2020. Importance and vulnerability of the world's water towers. *Nature*, Vol. 577, pp. 364–369. doi.org/10.1038/s41586-019-1822-y.

IPCC (Intergovernmental Panel on Climate Change). 2022. *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem and B. Rama (eds)]. Cambridge, UK/New York, Cambridge University Press. doi.org/10.1017/9781009325844.

—. 2023a. Summary for policymakers. H. Lee and J. Romero (eds), *Climate Change 2023: Synthesis Report*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, IPCC, pp. 1–34. www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf.

—. 2023b. *Climate Change 2023: Synthesis Report*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds)]. Geneva, IPCC, pp. 1–34. doi.org/10.59327/IPCC/AR6-9789291691647.001.

IRENA (International Renewable Energy Agency). 2023. *The Changing Role of Hydropower: Challenges and Opportunities*. Abu Dhabi, IRENA. www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_Changing_role_of_hydropower_2023.pdf.

Kashiwase, H. and Fujs, T. 2023. Strains on freshwater resources. A. F. Pirlea, U. Serajuddin, A. Thudt, D. Wadhwa and M. Welch (eds), *Atlas of Sustainable Development Goals 2023*. Washington DC, World Bank. doi.org/10.60616/93he-j512.

Kuzma, S., Saccoccia, L. and Chertock, M. 2023. 25 Countries, Housing One-quarter of the Population, Face Extremely High Water Stress. World Resources Institute website. www.wri.org/insights/highest-water-stressed-countries.

Laurent, L., Buoncristiani, J.-F., Pohl, B., Zekollari, H., Farinotti, D., Huss, M., Mugnier, J.-L. and Pergaud, J. 2020. The impact of climate change and glacier mass loss on the hydrology in the Mont-Blanc massif. *Scientific Reports*, Vol. 10, Article 10420. doi.org/10.1038/s41598-020-67379-7.

Lützow, N., Veh, G. and Korup, O. 2023. A global database of historic glacier lake outburst floods. *Earth System Science Data*, Vol. 15, No. 7, pp. 2983–3000. doi.org/10.5194/essd-15-2983-2023.

Mani, M. (ed.). 2021. *Glaciers of the Himalayas: Climate Change, Black Carbon, and Regional Resilience*. South Asia Development Forum. Washington DC, International Bank for Reconstruction and Development/The World Bank. https://openknowledge.worldbank.org/server/api/core/bitstreams/ff8b1264-d631-5d3d-814f-80f509c82aa9/content.

Mountain Partnership. 2013. *Why Mountains Matter for Energy: A Call for Action on the Sustainable Development Goals (SDGs)*. Food and Agriculture Organization of the United Nations. www.fao.org/fileadmin/templates/mountain_partnership/doc/POLICY_BRIEFS/SDGs_and_mountains_energy_en.pdf.

Romeo, R., Grita, F., Parisi, F. and Russo, L. 2020. *Vulnerability of Mountain Peoples to Food Insecurity: Updated Data and Analysis of Drivers*. Rome, Food and Agriculture Organization of the United Nations (FAO)/United Nations Convention to Combat Desertification (UNCCD). doi.org/10.4060/cb2409en.

Romeo, R., Manuelli, S. R., Geringer, M. and Barchiesi, V. (eds). 2021. *Mountain Farming Systems – Seeds for the Future: Sustainable Agricultural Practices for Resilient Mountain Livelihoods*. Rome, Food and Agriculture Organization of the United Nations (FAO). doi.org/10.4060/cb5349en.

Rounce, D. R., Hock, R., Maussion, F., Hugonnet, R., Kochtitzky, W., Huss, M., Berthier, E., Brinkerhoff, D., Compagno, L., Copland, L., Farinotti, D., Menounos, B. and McNabb, R. W. 2023. Global glacier change in the 21st century: Every increase in temperature matters. *Science*, Vol. 379, No. 6627, pp. 78–83. doi.org/10.1126/science.abo1324.

Shaban, A. 2020. Snow cover. A. Shabah, *Water Resources of Lebanon*. World Water Resources. Vol. 7. Cham, Switzerland, Springer. doi.org/10.1007/978-3-030-48717-1_5.

Stäubli, A., Nussbaumer, S. U., Allen, S. K., Huggel, C., Arguello, M., Costa, F., Hergarten, C., Martínez, R., Soto, J., Vargas, R., Zambrano, E. and Zimmermann, M. 2018. Analysis of weather-and climate-related disasters in mountain regions using different disaster databases. S. Mal, R. Singh and C. Huggel (eds), *Climate Change, Extreme Events and Disaster Risk Reduction: Towards Sustainable Development Goals*. Cham, Switzerland, Springer, pp. 17–41. doi.org/10.1007/978-3-319-56469-2_2.

Thornton, J. M., Snethlage, M. A., Sayre, R., Urbach, D. R., Viviroli, D., Ehrlich, D., Muccione, V., Wester, P., Insarov, G. and Adler, C. 2022. Human populations in the world's mountains: Spatio-temporal patterns and potential controls. *PLoS ONE,* Vol. 17, No. 7, Article e0271466. doi.org/10.1371/journal.pone.0271466.

Tremblay, J. C. and Ainslie, P. N. 2021. Global and country-level estimates of human population at high altitude. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, Vol. 118, No. 18, Article e2102463118. doi.org/10.1073/pnas.2102463118.

Trisos, C. H., Adelekan, I. O., Totin, E., Ayanlade, A., Efitre, J., Gemeda, A., Kalaba, K., Lennard, C., Masao, C., Mgaya, Y., Ngaruiya, G., Olago, D., Simpson, N. P. and Zakieldeen, S. 2022. Africa. H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem and B. Rama (eds), *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK/New York, Cambridge University Press, pp. 1285–1455. doi.org/10.1017/9781009325844.011.

UNECE/UNESCO/UN-Water (United Nations Economic Commission for Europe/United Nations Educational, Scientific and Cultural Organization/UN-Water). 2024. *Progress on Transboundary Water Cooperation: Mid-Term Status of SDG Indicator 6.5.2, with a Special Focus on Climate Change*. Geneva/Paris, United Nations/UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000391407?posInSet=1&queryId=1951bc54-df3b-44b4-9005-be568735fb16.

UNECLAC (United Nations Economic Commission for Latin America and the Caribbean). 2023. *Lithium Extraction and Industrialization: Opportunities and Challenges for Latin America and the Caribbean*. Santiago, UNECLAC. https://repositorio.cepal.org/server/api/core/bitstreams/8d505030-7686-44e1-9f60-77ceb0610826/content.

UNEP (United Nations Environment Programme). 2022. *A Scientific Assessment of the Third Pole Environment*. Nairobi, UNEP. www.unep.org/resources/report/scientific-assessment-third-pole-environment.

——. 2023. The Carpathian Convention marks its 20th Anniversary with a New Biodiversity Framework and a Transboundary Protected Wetland. UNEP website, 12 October 2023. www.unep.org/news-and-stories/press-release/carpathian-convention-marks-its-20th-anniversary-new-biodiversity.

——. 2024a. *Progress on Water-Related Ecosystems: Mid-Term Status of SDG Indicator 6.6.1 and Acceleration Needs with a Special Focus on Biodiversity*. Nairobi, UNEP. www.unwater.org/publications/progress-water-related-ecosystems-2024-update.

——. 2024b. *Adaptation Gap Report 2024. Come Hell and High Water: As Fires and Floods Hit the Poor Hardest, It Is Time for the World to Step Up Adaptation Actions*. Nairobi, UNEP. doi.org/10.59117/20.500.11822/46497.

——. 2024c. *Global Resources Outlook 2024: Bend the Trend – Pathways to a Liveable Planet as Resource Use Spikes*. Nairobi, International Resource Panel. https://wedocs.unep.org/20.500.11822/44901.

UNICEF/WHO (United Nations Children's Fund/World Health Organization). 2023. *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2022: Special Focus on Gender*. New York, UNICEF/WHO. www.who.int/publications/m/item/progress-on-household-drinking-water--sanitation-and-hygiene-2000-2022---special-focus-on-gender.

United Nations. 2024. *The Sustainable Development Goals Report 2024*. New York, United Nations. https://unstats.un.org/sdgs/report/2024/.

——. n.d.a. Progress on Drinking Water (SDG Target 6.1). United Nations website. www.sdg6data.org/en/indicator/6.1.1. (Accessed on 2 December 2024.)

——. n.d.b. Progress on Sanitation (SDG Target 6.2). United Nations website. www.sdg6data.org/en/indicator/6.2.1a. (Accessed on 4 December 2024.)

——. n.d.c. Progress on International Water Cooperation (SDG Target 6.a). United Nations website. www.sdg6data.org/en/indicator/6.a.1 (Accessed on 2 December 2024.)

Viviroli, D., Kummu, M., Meybeck, M., Kallio, M. and Wada, Y. 2020. Increasing dependence of lowland populations on mountain water resources. *Nature Sustainability*, Vol. 3, pp. 917–928. doi.org/10.1038/s41893-020-0559-9.

WHO (World Health Organization). 2022. *Strong Systems and Sound Investments: Evidence on and Key Insights into Accelerating Progress on Sanitation, Drinking-Water and Hygiene. UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) 2022 Report*. Geneva, WHO. https://iris.who.int/handle/10665/365297.

Zemp, M., Huss, M., Thibert, E., Eckert, N., McNabb, R., Huber, J., Barandun, M., Machguth, H., Nussbaumer, S. U., Gärtner-Roer, I., Thomson, L., Paul, F., Maussion, F., Kutuzov, S. and Cogley, J. G. 2019. Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. *Nature*, Vol. 568, No. 7752, pp. 382–386. doi.org/10.1038/s41586-019-1071-0.

Prepared by UNESCO WWAP | Chorong Ahn and Richard Connor

This publication is produced by UNESCO WWAP on behalf of UN-Water.

Cover artwork by Davide Bonazzi
Design and layout by Marco Tonsini

https://doi.org/10.54679/XBIH2127

UNESCO World Water Assessment Programme
Programme Office for Global Water Assessment
Division of Water Sciences, UNESCO
06134 Colombella, Perugia, Italy
Email: wwap@unesco.org
https://unesco.org/en/wwap

unesco
World Water Assessment Programme

We acknowledge with gratitude the financial support provided by the Government of Italy and Regione Umbria.

Regione Umbria

WWAP/SC-2025/PI/3